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PETROGRAPHY.[1]

Petrography of the Marquette Iron Range.—Van Hise and Bayley[2] in their recent description of the Marquette Iron Range in Michigan, give accounts of the petrography of the Archean and of the Algonkian rocks occurring in the region. The pre-Algonkian rocks comprise granite-gneisses, syenites, hornblendic and micaceous schists, and a series of green schists that are cut by peridotites, and by acid and basic dykes. The granites or gneisses are notable for the large quantity of microcline they contain. Although this is present in the most massive phases of the granite, it is much more abundant in those phases that are schistose as the result of pressure. These rocks are much crushed, and have developed in them great quantities of new plagioclase, quartz and muscovite in addition to the microcline above referred to. The syenites are mainly granitic aggregates of orthoclase and hornblende, with some plagioclase and a number of secondary products formed under the influence of pressure. These are the same in character as the secondary products formed in the granite under similar conditions. The green schists are squeezed surface materials. Some of them are squeezed tuffs and others squeezed lavas. The former contain numerous pebble-like masses that are taken to be bombs and rounded lava fragments. The present constituents of the schists are chlorite, sericite, calcite, plagioclase, quartz and sometimes epidote. Much of the plagioclase is in broken crystals lying in a matrix formed of smaller fragments of the same mineral cemented together by a felt of the others in a very finely crystallized groundmass. The structure of many of the schists is typically tuffaceous. These rocks indicate clearly the existence of volcanoes in pre-Algonkian time. The basic schists are associated with acid ones that seem to be squeezed rhyolitic lavas. Analyses of these two classes of schists follow:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	P_2O_5	CO_2	H_2O	Total
Basic schist	61.35	.26	16.45	.94	4.20	3.46	3.12	1.05	5.24	.18	1.98	2.61	= 100.84
Acid schist	70.76	.33	14.83	1.46	3.09	.36	1.99	3.50	.47	.26		2.79	= 99.84

The basic rocks cutting the gneisses and schists are diabases in various stages of alteration, and the acid ones are quartz porphyries. These have been carefully described by Williams.[3] The peridotite of the Marquette district was carefully described years ago by Wadsworth. The only additional fact of importance added by the authors with respect to this rock concerns its composition. An analysis of a very fresh specimen gave:

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[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Maine.

[2] Monograph XXVIII U. S. Geol. Survey, Washington, 1897.

SiO_2	TiO_2	Al_2O_3	Cr_2O_3	Fe_2O_3	FeO	MnO	NiO	CaO	SrO	BaO	MgO	K_2O	Na_2O	CO_2	P_2O_5	H_2O	Total
39.37	.66	4.47	.68	4.96	9.13	.12	.21	3.70	tr	tr	26.53	.26	.50	1.23	.17	7.95	= 99.94

A few hornblende-schists met with in certain portions of the area studied are shown to be altered igneous rocks, possibly recrystallized lavas.

The micaceous schists are well banded rocks with a distinct dip and strike. They are often interlaminated with thin bands of hornblende-schists with which they are perfectly conformable. These micaceous schists embrace muscovite-schists, biotite-schists and feldspathic biotite-schists, most of which are so much decomposed that their original composition is difficult to determine. It is probable that they are crystallized acid lavas or tuffs.

In the Algonkian series are quartzites, conglomerates, graywackes, slates, dolomites, grünerite-magnetite schists, jaspilites, mica-schists and a series of basic tuffs that have suffered metamorphism until they are now largely hornblende-biotite-schists. The production of hornblende in these tuffs is on a very extensive scale. The amphibole is in large plates that are more or less idiomorphic, and nearly all of these are cellular in structure. The greenstones that are intrusive in the iron formation are altered diabases, in only a few of which augite can still be detected. These rocks have heretofore been generally known as diorites. In the western part of the district where the squeezing has been more intense than elsewhere much quartz and biotite has been developed in them, and the rocks present a very different aspect from the more normal phases.

All the rocks mentioned above are described in detail, and many colored reproductions of polished hand specimens of limestones, slate and jaspilite illustrate the report.

The Rock-formation of the Silver Cliff and Rosita Hills District, Colorado.—The mines of the Silver Creek and Rosita district are mainly in volcanic rocks. The eastern portion of the area is the seat of an old volcano which erupted andesite, rhyolites and trachytes both in lava and in tuff form. These constitute the Rosita Hills. North and east of these are the old granites and gneisses. In the

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[3] Bull. 62 U. S. Geol. Survey.

neighborhood of Silver Cliff only the rhyolites are present. The granites intrude the gneisses, both being early Cambrian or pre-Cambrian. The volcanic series dates from the early Eocene; in this and in some other respects being like similar rocks at Cripple Creek and at other volcanic centres in the State. Both the Rosita and the Cripple Creek volcanoes are regarded as small outlying vents connected in origin with the much larger eruptions of the San Juan and South Park regions.

The gneisses of the Silver Cliff-Rosita Hills district are described by Cross[4] as variable in composition, no one type persisting over any great area. They consist of microcline, orthoclase, quartz and biotite, muscovite, hornblende or augite, and by variation in the amounts of either one or several of these constituents they grade into quite different types. The quartz and the bisilicates are often segregated in thin layers or streaks, thus giving the gneiss a banded aspect. Among the principal types represented in the complex, the augite-hornblende-gneiss is the most definite. It is a basic gneiss composed of a basic plagioclase and numerous intergrowths of augite and hornblende. The old gneisses and granites are cut by dykes of syenite, diabase and peridotite.[5]

The earliest member of the volcanic series is a hornblende-mica-andesite which occurs principally as a tuff. This was followed by massive effusions of an augite-biotite-andesite containing large phenocrysts of orthoclase and small crystals of plagioclase surrounded by orthoclase rims. The andesites are cut by dykes of an augite diorite containing biotite and altered olivine, and in some facies of the rock considerable orthoclase.

A later lava than the andesite was the dacite, which differs from the augite-andesite in the presence of quartz and in the subordination of the dark silicate to the feldspars. Orthoclase is absent from the dacites, and the plagioclases present are nearly all andesine.

The next in age and the most abundant of the lavas are rhyolites. These vary greatly in character, but nearly all phases are devoid of dark silicates. They occur in massive and in banded ledges, and in others remarkable for the great abundance in them of very large spherulites. These have been carefully studied by the author and reported upon in another place. In addition to the lavas tuffs, agglomerates and other evidences of explosive volcanic activity are noted in the vicinity of Rosita. Following the rhyolite came another biotite-augite-andesite, and finally a trachyte of normal character.

[4] 17th Ann. Rep. U. S. Geol. Survey, p. 269.

[5] Cf. Proc. Colorado Sci. Soc., Vol. II, 1887, p. 223.

One of the most interesting rocks of the district is the Bassick Mine agglomerate made up of fragments of many different rocks cemented by fine debris of the same character. This is now usually so much decomposed that its original constituents can in many cases no longer be recognized.

In addition to the volcanic rocks mentioned above, a mica-dacite and a limburgite were observed. They are, however, quite rare. All the volcanic rocks have been decomposed by solfataric action, yielding products of various kinds, the two most important of which are a white siliceous clay resulting from the alteration of pitchstone and a quartz alunite rock produced from rhyolite. Analyses of the pitchstone and its alteration product follow:

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	K_2O	Na_2O	H_2O	Total
Pitchstone	71.56	13.10	.66	.28	.16	.74	.14	4.06	3.77	5.52 =	99.99
Clay	71.71	12.36	1.10		.17	1.11	1.21	.36	.17	11.97 =	100.16

The andesite is often muscovitized, all of its constituents but augite and orthoclase passing over into aggregates of muscovite apparently with great ease.

The report closes with a discussion of differentiation in which the author does not reach any definite conclusions, except that in the case of the Rosita rocks much of the differentiation which resulted in the different phases of the various types must have taken place either after the lavas had reached their present position, or at any rate at no great depth under the surface.

Notes.—Wolff[1] gives a description and a map of the exposures of eruptive rocks occurring in Sussex Co., N. Y. These exposures include those of the well known eleolite-syenite and associated dyke rocks at Beemerville.

PALÆONTOLOGY.

Schuchert's Synopsis of American Fossil Brachiopoda.[2]—Students of Brachiopoda, as well as Mr. Schuchert, are to be congratulated upon the publication of this important work. Its preparation has extended over a period of eleven years, and entailed references

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[1] Ann. Rep. State Geol. of New Jersey for 1896, p. 91.

[2] A Synopsis of American Fossil Brachiopoda, including Bibliography and Synonymy. By Charles Schuchert, Bulletin U. S. Geol. Survey, No. 87. 8°, 464 pp., Washington, 1897.